ARRANGEMENT FOR INPUT MULTIPLEXER

BACKGROUND OF THE INVENTION

The invention relates to an input multiplexer (IMUX). This input multiplexer splits a broad frequency band into a series of narrow frequency bands. This is accomplished by filtering each frequency channel with a bandpass filter. In each case, the filters have an input and an output and must be connected suitably with one another.

The bandpass filters must fulfill strict specifications with respect to the frequency response of the amplitude as well as the phase response. Within the pass band of the bandpass filter, the variation in the phase or group delay is to be minimized and, at the same time, the filters must have a high selectivity. This selectivity is achieved by placing zeros of the transmission function on the imaginary frequency axis close to the pass band. Additional measures are required in order to fulfill the requirement of little variation in the group delay in the pass band. For this purpose, essentially three different developments are state of the art.

In a first embodiment, the filter itself is of minimum phase type, that is, aside from the already mentioned transmission zero, it has no other zeros in the

transmission function. In addition, the filter has an external group delay equalizer. Frequently, the bandpass filter has the order 8 and the equalizer has the order 2.

In a further embodiment, the filter is self-equalizing, that is, aside from the zero positions of the transmission function mentioned, the bandpass filter has further ones with a finite real part. In this connection, the filter frequently has the order 10 or 12, which is known, for example, from US patent 5,608,363 especially for realization in a dielectric technology.

In the case of the third embodiment, the bandpass filter itself is also self-equalizing, as described above. In addition, however, and external group delay equalizer is added. The filter frequently has the order 10 or 12 here and the equalizer the order 1 or 2. Such a development is described, for example, in US patent 5,739,733, for which the electrical properties of the self-equalizing filter are improved by additional external group delay equalizers, which cancel the slope in the group delay.

The arrangement, with which the bandpass filters are coupled to one another, frequently consists therein that, initially, the signal input is split by means of a hybrid coupler or a power splitter into two equal parts, that is, each part is acted upon with half the signal level. Each of the two signal paths is

processed further in that the signal is passed through a circulator chain to the bandpass filter. If the number of bandpass filters is n and if the bandpass filters are numbered 1, 2, 3, ... n in the sequence, in which their center frequency increases, each of the two circulator chains connects the next neighbor but one, that is, the one circulator chain connects the bandpass filters 1, 3, 5, ... n-1 and the other circulator chain the bandpass filters 2, 4, 6, ... n (if n is an even number; if n is an odd number, the two circulator chains contain the bandpass filters 1, 3, ... n and 2, 4, ... n-1 respectively). Such an arrangement is called non-contiguous, since each circulator chain only couples bandpass filters, the band limits of which do not lie directly next to one another in the frequency domain.

It is a disadvantage of these arrangements that circulators change their electrical properties as a function of the temperature and, in the overall arrangement, the circulator frequently is the limiting element for the temperature range, in which the overall arrangement still has the required properties. On passing through a circulator, the high frequency signal experiences appreciable high-frequency losses. Moreover, the individual signal outputs of an IMUX with circulator chains are dampened differently, since the signal, before passing through the bandpass filter, has experienced a different number of circulator passages. This effect is undesirable. Moreover, circulators contain magnetic and

ferrite materials, which have an appreciable density. For this reason, circulators make an appreciable contribution to the total weight of the IMUX. Moreover, these magnetic and ferrite materials are used only in the circulators and require assembly and integration techniques, which are also used only in the circulator. Consequently, the assembly and testing require an appreciable effort. Moreover, the reliability of the arrangement as a whole is adversely affected by the circulators, which contribute appreciably to the price of the IMUX.

Arrangements, for which the signal input is divided by means of hybrid couplers or power splitters not only into two but into several branches, which then terminate once again in circulator chains, are also used. Finally, it is also possible to divide the signal inputs in the bandpass filter exclusively by hybrid couplers or power splitters. These cause a disadvantageous signal attenuation of 3 dB and, in addition, have disadvantageous weights and volumes.

The arrangements for coupling bandpass filters, described so far, are used in the IMUX equipment. However, in order to understand the invention, a further device, the OMUX, must also be taken into consideration. This is similar to the IMUX, in that it does not split a broad frequency band into a series of narrower frequency channels, but, conversely, combines a series of narrower frequency channels into a broad frequency band. However, it is clearly different from the

IMUX, since it must process signals of a much higher power (in the OMUX, approximately 100 W per frequency channel, in the IMUX, approximately 1 mW per channel) and it is therefore a primary design objective to minimize losses. In comparison to the IMUX, it is simpler in the case of the OMUX that the individual bandpass filters only have to satisfy requirements, which are less strict and can generally be all observed with filters of a low order (4 or 5). In particular, it is usually not necessary to take measures to ensure a flat group delay within the pass band. In order to achieve low losses, the individual bandpass filters of the OMUX are combined with a manifold, as described in US patent 4,614,920. This consists exclusively of pieces of transmission lines of suitable length and therefore has only low losses. The manifold combines bandpass filters, which are immediately adjacent to one another in the frequency space. For this reason, the arrangement is considered to be contiguous.

SUMMARY OF THE INVENTION:

An input multiplexer of the present invention is advantageously embodied as high order bandpass filters which satisfy strict requirements with respect to selectivity and have little variation in group delay within the pass band, and which are connected into an IMUX by means of a low-loss manifold formed exclusively of pieces of transmission lines of optimized length. Moreover, the

bandpass filters have zeros in the transmission function on the imaginary frequency axis close to the pass band in order to improve the selectivity, and, in addition for group delay equalization, have either an external group delay equalizer or further zeros in the transmission function with a finite real part or a combination thereof.

According to an advantageous [development] embodiment of the invention, the manifold connects bandpass filters, which are not directly adjacent to one another in the frequency domain (non-contiguous).

According to a further advantageous [development] embodiment of the invention, the manifold connects bandpass filters, which are directly adjacent to one another in the frequency domain (contiguous).

According to a further advantageous [development] embodiment, the invention is realized in both embodiments in different technologies. In particular, these are the waveguide technique, the coaxial technique, the dielectric technique and the planar technique, the latter, in particular, in conjunction with superconducting materials. The individual bandpass filters and manifold can be realized in different technologies.

According to a further, advantageous embodiment of the invention, the geometry realized is combline or herringbone in both configurations, that is, the

bandpass filters are all mounted on one side of the busbar or half on one side and half on the opposite side, so that the available space is used optimally, depending on the particular application.

According to a further, advantageous embodiment of the invention, the bandpass filters are operated in single mode, dual mode, triple mode or quadruple mode in both configurations. Arbitrary combinations of these are also possible.

According to a further, advantageous embodiment of the invention, the filters, with respect to their center frequency, are connected in any sequence with the manifold.

According to a further advantageous embodiment of the invention, the arrangement contains devices for trimming the filters and/or the manifold.

Further advantages and advantageous embodiments of the invention are given in the following description, the drawing and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 shows high order IMUX filters, which are connected through two manifolds with a hybrid coupler, and

Fig. 2 shows high order IMUX filters, which are connected with a low-loss manifold.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

As shown in Fig. 1, there is a low-loss [busbar] manifold 1, which connects the bandpass filters 1, 3, ..., (n-1) and a further low-loss [busbar] manifold 1 for the remaining filters 2, 4, ..., n. The IMUX filters of high order are connected non-contiguously over these two [busbars] manifold 1 and the two manifolds are connected through a hybrid coupler 2 to the IMUX device as a whole. The identical half for f2, f4 ..., fn conceivably adjoins at the bottom.

As shown in Fig. 2, the low-loss manifold 1 connects the IMUX bandpass filters of high order 1, 2, ..., n, which are directly adjacent in the frequency space, with one another.

All distinguishing features, disclosed in the specification, the subsequent claims and the drawing, may be applied to the invention individually as well as in any combinations with one another.